PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:	WO 92/14030
E21B 43/01	A1	(43) International Publication Date:	20 August 1992 (20.08.92)

(21) International Application Number: PCT/NO92/00025

(22) International Filing Date: 6 February 1992 (06.02.92)

(30) Priority data:
910501 8 February 1991 (08.02.91) NO

(71) Applicant *(for all designated States except US)*: KVÆRNER ROSENBERG A.S [NO/NO]; Kværner Subsea Contracting, Hoffsveien 1, N-0275 Oslo (NO).

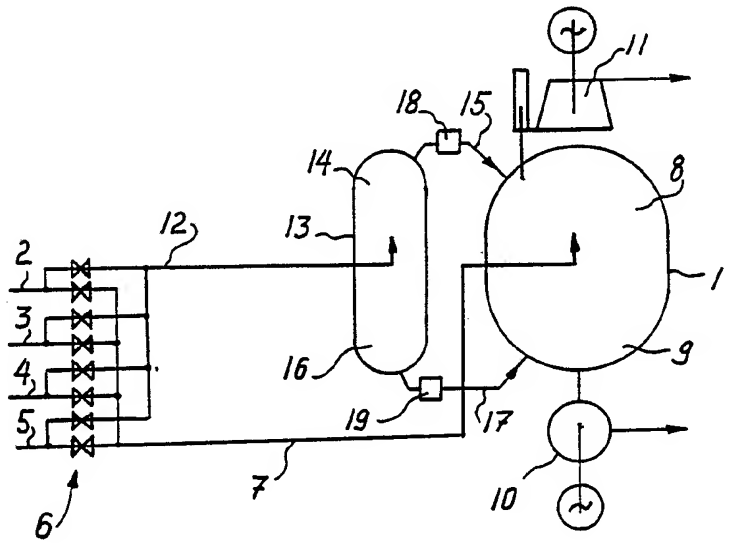
(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : STINESSEN, Kjell, Olav [NO/NO]; Industrigaten 38B, N-0357 Oslo (NO). KJELLAND-FOSTERUD, Einar [NO/NO]; Hosletoppen 30, N-1347 Hosle (NO).

(74) Agent: REISTAD, Gunnar, Ole; Bryns Patentkontor a/s, Postboks 9566, Egertorget, N-0128 Oslo (NO).

(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.
In English translation (filed in Norwegian).

(54) Title: A METHOD OF TESTING A WELL STREAM AND A SYSTEM FOR TESTING A WELL STREAM, PARTICULARLY ON THE SEABED



(57) Abstract

For testing a well stream, a portion of the well stream is separated out, tested and conducted back to the well stream. The diverted portion is separated in a test separator (13), in which the gas chamber (14) is connected with a gas chamber (8) in a well stream separator (1), while the liquid chamber (16) has flow connection with the liquid chamber (9) in the well stream separator, in such manner that the level in the test stream separator (16) substantially follows the level in the well stream separator. The testing is carried out by testing of the respective gas and liquid streams from the test separator (13) to the well stream separator (1).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CS	Czechoslovakia
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
PL	Poland
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

A METHOD OF TESTING A WELL STREAM AND A SYSTEM FOR TESTING A WELL STREAM, PARTICULARLY ON THE SEABED.

The invention relates to a method of testing a well stream, particularly on the seabed, where a portion of the well stream is separated out, tested, and conducted back to the well stream.

The invention also relates to a system for testing a well stream, particularly on the seabed, comprising a well stream pipeline, a test stream pipe circuit connected in parallel with the well stream pipeline, and testing equipment for testing the test stream bifurcated by the parallel-connected test stream pipe circuit.

When underwater production takes place from a plurality of hydrocarbon wells, it is of major interest to be able to determine the pressure, temperature, gas and liquid production, and the oil to water ratio from each well separately.

For a field where the well pressure is sufficient, the subsea system may be constructed such that the flow from a well may be conducted through a test manifold and a separate pipeline up to the surface, while the rest of the production is conducted through the main manifold and the main pipeline.

In some fields the well pressure will not be sufficient to drive the production to the surface with the pressure that is required by the receiving station. It would then be of major interest to utilize a subsea station comprising an underwater separator for the well stream, a pump and, if desired, a compressor.

To enable the testing of a well in a field having an subsea station of this type, there are basically two possibilities:

The test production may be conducted to the surface for measurement. Since it is assumed that the pressure in this case is inadequate, the procedure requires the installation of a separate auxiliary system dimensioned for production from a well. This auxiliary system must include a separator and a pump, and often also a compressor.
The second possibility is to carry out the measurements on the seabed. Instruments are available which can measure the desired magnitudes after the gas and liquid are separated.

The present invention relates to a method and a system which enables this type of testing or measurement on the floor of the sea.

The testing or measurement of a test stream separated out from a well stream in a parallel-connected test stream pipe circuit is known from an address presented at the Offshore Technology Conference 1990 in Houston, Texas, published in the printed version as OTC 6426 with the title, "A New Microwave Based Water-Cut Monitor Technology," by G.J. Hatton, D.A. Helms, J.D. Marrelli and M.G. Durrett, Texaco, Inc. It describes the measurement of the liquid portion only, however, and the equipment described therein permits only the branching off, or bifurcation, from one well stream pipeline.

The particular intent of the present invention is to enable a bifurcation and testing of both the liquid and gas phase from one well stream pipeline selected among a plurality of well stream conduits.

A special objective of the invention is also to make possible the testing of a well stream in a subsea facility of the type shown and described in NO application no. P890057 (US Serial no. 07/460 398 filed March 1, 1990).
Such a subsea facility comprises a well stream separator, where the well stream is separated into liquid and gas, a

pump for the supply of energy to the separated liquid, and a compressor for the supply of energy to the separated gas.

According to the invention, therefore, we propose a method of testing a well stream, particularly on the seabed, where a portion of the well stream is separated out, tested and conducted back to the well stream, characterized in that the diverted portion, as a test stream, is separated into gas and liquid in a test separator, in which the flow connection between the gas chamber thereof and the gas chamber in a well stream separator, and between the liquid chamber thereof and the liquid chamber in the well stream separator is such that the level in the test stream separator substantially follows the level in the well stream separator, and in that the testing of gas and/or liquid is carried out by testing the respective gas and liquid streams from the test separator to the well stream separator.

According to the invention there is also proposed a system for testing a well stream, particularly on the seabed, comprising a well stream pipeline, a test stream pipe circuit connected in parallel with the well stream pipeline, and test equipment for testing the test stream bifurcated by the parallel-connected test stream pipe circuit, characterized by a well stream separator connected to the well stream pipeline, having a liquid section and a gas section,
a test stream separator in the test stream pipe circuit having a liquid section and a gas section,
a liquid flow line from the liquid section of the test stream separator and to the liquid section of the well stream separator, and a gas flow line from the gas section of the test stream separator and to the gas section of the well stream separator, said arrangement being such that the level in the test stream separator substantially follows the level in the well stream separator,
and by the test equipment being disposed in said liquid flow line and/or gas flow line.

With the invention one is able to retain the advantages inherent in working on the seabed, in that one avoids having a test pipeline to the surface, a test pump and, in some cases, a test compressor. The system may readily be attached to a plurality of well streams, i.e., to a manifold to which several well stream pipelines are connected, for collective further delivery to the well stream separator. A substantial advantage is achieved by the fact that the level in the test stream separator follows the level in the well stream separator, because one is thereby spared the provision of a separate level control (measuring instrument, control loop and regulating valve) for the test stream separator.

According to the invention, the test stream separator may advantageously be placed within the well stream separator. One thereby conserves both space and steel weight. The test stream separator may thus also be of lightweight construction, since it is not subjected to any appreciable pressure differences.

The invention shall be explained further with reference to the drawings, where:

Fig. 1 in purely schematic form shows a system according to the invention, and

Fig. 2 in purely schematic form shows a different embodiment of a system according to the invention.

In Fig. 1 a well stream separator is designated with 1. This separator 1 is situated in an underwater station. A plurality of well stream pipelines 2, 3, 4 and 5 lead from oil wells, not shown, on the seabed and are collected in a manifold 6. From there a well stream pipeline or main line 7 runs to the separator 1. The well stream pipeline 7 flows into the separator in a manner known per se in the gas section 8 of

the separator. The separator's liquid section is indicated by 9.

The separator's liquid section 9 is connected with a pump 10. The separator's gas section 8 is connected with a compressor 11.

From manifold 6, a test stream pipe 12 runs to a test stream separator 13. The test stream pipe 12 flows into the test stream separator 13 in the gas section 14 thereof. From the gas chamber 14 in the test stream separator, a flow line 15 goes to the gas chamber 8 in the well stream separator. From the liquid section 16 in the test stream separator goes a flow communication 17 to the liquid section 9 in the well stream separator. It is apparent from the arrangement in Fig. 1 that the liquid level in the test stream separator 13 will be nearly equal to the liquid level in the well stream separator 1, provided that the piping is so arranged as to minimize flow resistance, and that there is no possibility for liquid or gas seals.

Appropriate measuring equipment 18 is built into the gas flow line 15. Similarly, suitable measuring equipment 19 for the liquid fraction is built into the liquid flow line 17.

In a practical embodiment of the test stream separator 13, the volume required to ensure adequate separation will correspond to the volume flow in 10 minutes of test production. This is so little that it may be assumed that the flow out of the test stream separator at any given time equals the flow into the test stream separator, which is a precondition for being able to measure the test stream with high accuracy in a simple manner.

The system outlined in Fig. 2 functions in the same manner as the system in Fig. 1, and the same reference numerals have therefore been used for the corresponding components. In

terms of the unit itself, one difference is that the test stream separator 13 is built into the well stream separator 1. This enables the conservation of both space and steel weight. The savings can be illustrated by the following exemples:

Required diameter for the well stream separator 1 = 2.6 m

Required diameter for the test stream separator 13 = 1.0 m

To retain the same surface area in the well stream separator 1 with the test stream separator mounted within the well stream separator, the diameter of the well stream separator in this example must be increased to 2.78 m. The test stream separator may, moreover, be of lightweight construction, since it is not subjected to any appreciable pressure difference.

Patent Claims

1.

A method of testing a well stream, particularly on the seabed, where a portion of the well stream is separated out, tested and conducted back to the well stream,
characterized in that the diverted portion, as a test stream,is separated into gas and liquid in a test separator, in which the flow connection between the gas chamber thereof and the gas chamber in a well stream separator, and between the liquid chamber thereof and the liquid chamber in the well stream separator is such that the level in the test stream separator substantially follows the level in the well stream separator, and in that the testing of gas and/or liquid is carried out by testing the respective gas and liquid streams from the test separator to the well stream separator.

2.

A system for testing a well stream, particularly on the seabed, comprising a well stream pipeline 7, a test stream pipe circuit (12,15,17) connected in parallel with the well stream pipeline, and test equipment (18,19) for testing the test stream bifurcated by the parallel-connected test stream pipe circuit, characterized by a well stream separator (1) connected to the well stream pipeline (7), having a liquid section (9) and a gas section (8),
a test stream separator (13) in the test stream pipe circuit having a liquid section (16) and a gas section (14),
a liquid flow line (17) from the liquid section (16) of the test stream separator to the liquid section (9) of the well stream separator, and a gas flow line (15) from the gas section (14) of the test stream separator to the gas section (8) of the well stream separator, the arrangement being such that the level in the test stream separator substantially follows the level in the well stream separator, and by the

test equipment (18,19) being disposed in said liquid flow line (17) and/or gas flow line (15).

Fig. 1

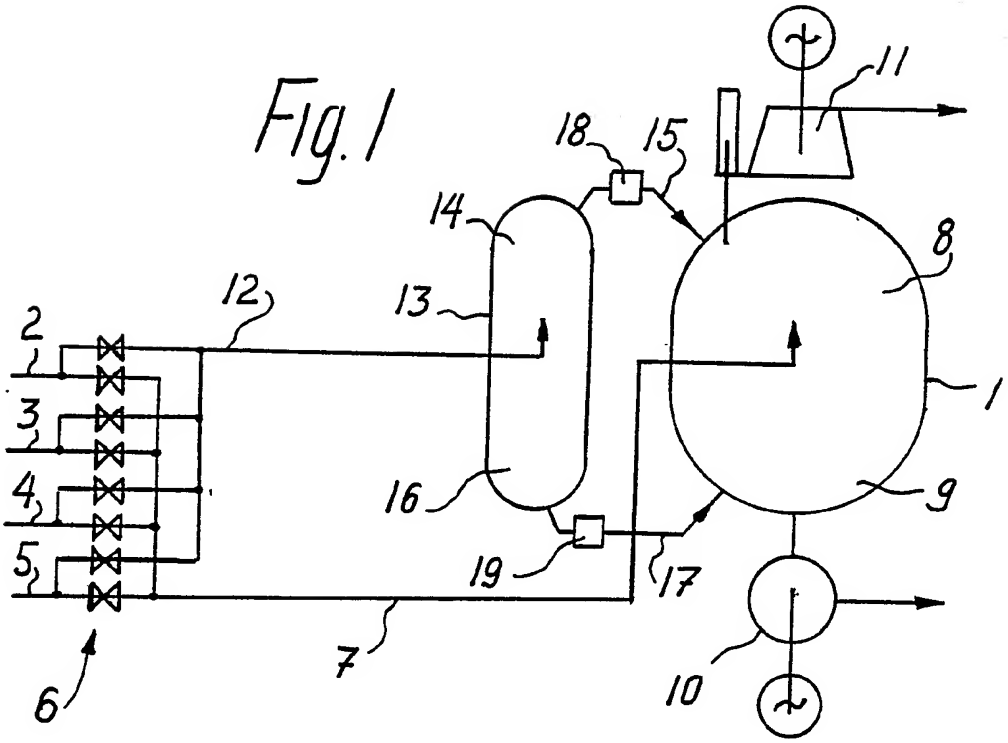
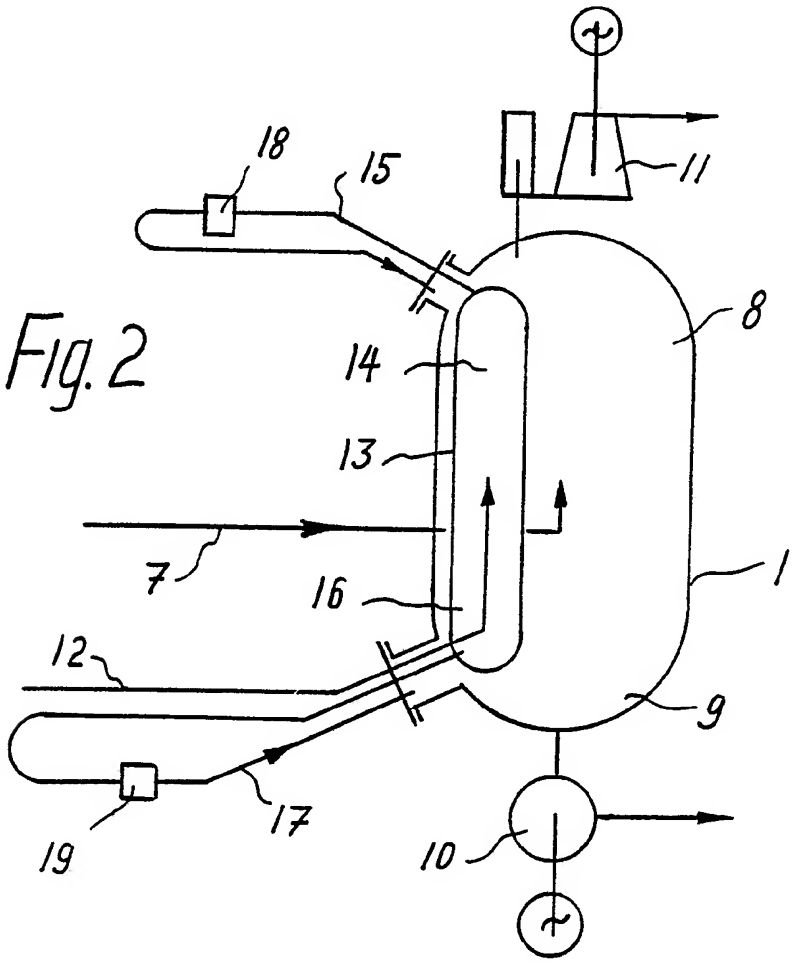

11
18
15
14
8
12
13
2
3
4
5
1
16
9
19
17
7
10
6

Fig. 2


18
15
11
8
14
13
7
16
1
12
9
17
19
10

INTERNATIONAL SEARCH REPORT

International Application No PCT/NO 92/00025

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: E 21 B 43/01

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	E 21 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US, A, 4616700 (J.R. WOOD ET AL) 14 October 1986, see column 3, line 30 - column 4, line 30 --	1-2
X	US, A, 4951700 (P.A. KALMAN) 28 August 1990, see especially column 2, line 65 - column 3, line 40 and figure 1 --	1-2

---

* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13th May 1992	1992 -05- 18
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Christer Bäcknert

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/NO 92/00025

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 28/03/92
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4616700	86-10-14	NONE	
US-A- 4951700	90-08-28	EP-A- 0332829	89-09-20